Protocol Two: Ground Observations and Biometry

Purpose

To carry out observations and measurements in your Biology and Quantitative Land Cover Study Sites.

Overview

Measurements in forested or grassland areas can be used to determine photosynthetic production.

Level

Beginning, Intermediate and Advanced

Time

One-half to one full day

Frequency

One or two times per year for your Biology Study Site.
Once for your Quantitative Land Cover Study Sites.

Key Concepts and Skills

Concepts

Pixel size
Canopy cover
Ground cover
Tree height and circumference
Grass biomass
Dominant and co-dominant species
Land cover classification

Skills

Using clinometer and densiometer
Using compass directions
Making ground measurements
Identifying species
Using dichotomous key
Measuring pace

Materials and Tools

Forested pixel

- Dichotomous keys
- Clinometer
- Tubular densiometer
- 50m tape
- Compass
- Tape measure
- Local road or topographic maps
- Marking stakes/flags (5)
- Color printed copy of local 512 x 512 pixel scene in visible (3,2,1) and NIR (4,3,2)
- GPS unit
- Field forms

Grassland pixel

- Grass clippers or strong scissors
- Large collection bag
- Marking flags or 1 m square frame
- Brown paper bags
- Drying oven
- Balance, accurate to 0.1 g
- GPS unit

Preparation

Select site(s)
Practice measurement protocols beforehand

Prerequisites

None

As described above, observations and measurements made on the ground by your students are a critical part of the Land Cover protocols. You and your students will observe and record the type of land cover in your Biology and Land Cover Study Sites and, if they are naturally vegetated, will identify the dominant vegetation species present. In addition, you will perform a series of measurements, referred to as "biometry." Biometry measurements will be made of canopy cover, ground cover, tree height and tree circumference, the "biomass" of grass cover, and the seasonal changes, or "phenology," of the vegetation. Each of the observations and measurements is described in the sequence of protocols that follows.

1. Establishing Your 30 m x 30 m Biology Study Site and 90 m x 90 m Land Cover Study Site

In the beginning of this section, you learned how to select the locations of ground sites for detailed observation. Here you are given instructions for actually laying out these sites.

Determining Pace

It is important to know what an individual's pace measures. This value is useful in the tree height, canopy/ground cover, and site layout protocols.

A rough estimate of distance is often used in field work, such as the length of sampling transects or the size of a square or rectangular study plot. A simple way of doing this is to pace those distances. By knowing the length of your pace and by counting the number of paces needed to cover the distance, you may then calculate that distance.

The following method will be used:

1. A pace is two steps.

Example:

Trial 1	17.0m (10 paces)	= 1.7m (single pace)
Trial 2	17.5m	= 1.75m
Trial 3	16.8m	= 1.68m
Average	1.71m	

2. Lay out your 50m measuring tape on a flat, open area (a parking lot, field, or hallway is good).
3. Noting whether your foot has the toe or the heel on the 0m mark on the tape, pace off 10 paces, using a normal stride.
4. Note the marking on the tape where the toe or heel stops on the tenth pace.
5. Divide that value by 10 to find your pace.
6. Repeat this measurement three times and calculate the average of the three.

Establishing Your Biology Study Site

Using a compass and a 50 m measuring tape, you will establish a 30m x 30m Biology Study Site. You will then measure and mark the diagonals of this plot which will be used for the ground cover and canopy closure assessments.

1. At your Biology Study Site, place a marker at a location designated to be one of the corners of the study site.
2. Establish side 1. Measure 30 meters to the north or south from your initial marker (OR 30 meters to the east or west). Place a second marker at the end of this 30 meter transect.
3. Establish side 2. From the second marker, measure another 30 meter transect perpendicular to side 1. (If side 1 is on a north-south orientation, then side 2 will be on an east-west orientation.) Place a third marker at the end of this 30 meter transect.
4. Establish side 3. From the third marker, measure another 30 meter transect perpendicular to 2. (If side 2 was on an east-west orientation, then side 3 will be on a north-south orientation.) Place a fourth marker at the end of this 30 meter transect.
5. Establish side 4. From the fourth marker, measure another 30 meter transect perpendicular to side 3. (If side 3 was on a north-south orientation, then side 4 will be an east-west orientation.) You will have been successful if your 30 meter transect ends at or close to your first marker.

If you are far from the mark, check compass headings for each side again. Make sure they are either north-south orientations or east-west orientations. Check the length of each side, making sure they are each 30 meters long.

Establishing a 90 m x 90 m Land Cover Study Site

Repeat steps 1 - 5 above, measuring transects that are 90 meters rather than 30 meters. Refer to Figure 4-2 and Figure 4-11.

Refer to the Site Seeing learning activity

2. Identification of Dominant and Co-Dominant Species

When to Do Species Identification

Students will do species identification in each study site once during the course of the GLOBE program at your school. This is best accomplished when plants are leafed-out, and weather permits easy access (i.e., no snow or mud).

Establishing Dominant and Co-Dominant Species

After locating and laying out your Biology and Land Cover Study Sites, you will begin to characterize the land cover within the site. This will be accomplished within the 30 x 30 meter "pixel" which is either your Biology Study Site or is the center pixel of your 90 x 90 meter Land Cover Study Site. First, identify the cover type using the MUC classification system found in the beginning of this protocol and in the MUC Glossary in the Toolkit. Identifying the dominant and co-dominant species on the site follows the MUC classification process as follows.

1. If your site is classified as Urban, Cultivated Land, Open Water, or Barren (MUC level 1 classes 9, 8, 7, or 5), do not continue with the identification of dominant species. Simply classify the site to its MUC level 2 or 3 category (carry the classification as far as the scheme will go). Note any significant features, such as the state of growth of any agricultural crop, and take and record photographs. Remember: stand in the center of your site and take a photograph facing each major compass direction; north, south, east and west.

2. Establishing dominant and co-dominant species uses the same method you will employ to measure canopy and ground cover, explained in the Biometry section below. It is also the first step in identifying the MUC classification for naturally vegetated sites (vegetated sites which are not extensively human-controlled as by agriculture or landscaping). Because of the need to identify species during the procedure, you may want to establish dominant/co-dominants as an independent activity, rather than at the time you measure canopy/ground cover, but you can do both at the same time if you wish. In any case, before proceeding read the procedure for canopy/ground cover in the Biometry section below .

3. Use pairs of students, one to record and one to observe the ground and canopy. Have the pair walk two diagonal transects from corner to corner in the 30 x 30 meter plot. After each pace, record the species overhead (if the crosshairs on the tubular densiometer intercept vegetation) and the species on the ground (if vegetation is touching the foot or leg of the observer). At this point, it is not necessary to know the scientific names of all the species encountered. Use common

plants names if known, or you may even invent names for the plants which are commonly encountered.

4. Tabulate and calculate the results as explained in the section on canopy/ground cover. If canopy cover is 40% or greater, then your plot is a forest, woodland, or shrubland (MUC Level 1 class 0, 1, 2, or 3) and the dominant species is the tree or shrub encountered most frequently when looking up through the densiometer, and the co-dominant is the second most frequently encountered tree or shrub.
5. If canopy cover is less than 40% (MUC classes 4 or 6), then the ground species with the most tallies is the dominant, and the co-dominant is the species, ground or canopy, with the second most tallies.
6. Identify the tree or understory species represented by each specimen/plot using dichotomous keys or by consulting local experts (see *"Making the Species Identification"*).
7. Enter the first 4 letters of the genus and of the species of each of the two dominant species on the field form.

It may be difficult to identify dominant and/or co-dominant species if the vegetation in your site is extremely diverse. This can happen particularly with regard to ground cover, which may consist of a complex mixture of grasses, broad-leaf plants, short bushes, vines, etc. If there seems to be enough ground cover to qualify as a dominant or co-dominant as described above, but it is not clearly dominated by one or two species, describe the vegetation as best you can in the "notes" on the field form, and enter "mixed" in the dominant/co-dominant species line. Very diverse forests may have to be treated this way as well.

Making the Species Identifications

For GLOBE schools in the Eastern and Central United States, teachers will be provided the following dichotomous key: "What Tree is That? A Guide to the More Common Trees Found in the Eastern and Central U.S." by The National Arbor Day Foundation.

For GLOBE schools in the Western U.S., teachers will be provided the following key: "What Tree is That? A Guide to the More Common Trees Found in the Western U.S." by The National Arbor Day Foundation.

For GLOBE schools in countries other than the U.S., consult a local authority for the best method for identifying species of vegetation in your area. The local authority may be a forester (in the case of tree identification) or specialist (knowledgeable on local species of grasses, shrubs, etc.), a research scientist at the nearest university or college, or perhaps a parent or teacher who is familiar with vegetation in your area. Such an expert should be consulted for information on the appropriate dichotomous key or field guide to be used by the students. Perhaps this person could also visit your classroom and check the student identifications. Your GLOBE Country Coordinator may be able to suggest someone who has agreed to work with GLOBE schools to identify local species.

Even in the U.S., the key "What Tree is That?" was suggested for use only as a convenient and easy-to-use first step in identifying tree species. It is designed only to identify commonly occurring native trees, and you may find that it cannot be used in identifying trees that are present in your study sites. Sites having significant non-forest vegetation types will require use of another key or consultation with a local expert.

If you have access to a good dichotomous key for your area, this is the preferred way to identify species because it introduces students to this standard method of scientific species identification. The following examples introduce how dichotomous keys are used.

Example 1: Using A Dichotomous Key

"Dichotomous" is a term which comes from the Greek words dikha, in two, and temnein, to cut. Thus the meaning is: division into two usually contradictory parts. One definition of "key" is a table, glossary, or cipher for decoding or interpreting. A dichotomous key is therefore a branching decoder, characterized by successive forking into two approximately equal and contradictory divisions, which leads to only one correct outcome. This is much the same as the maze that a mouse is placed into. For the mouse to get out of the maze it must constantly make a choice between two directions to travel, one correct and one not correct. The mouse will only get out after making all the correct choices.

How do we use a dichotomous key? As we have just found out, a dichotomous key presents us with two choices that are contrary to each other and we must choose the correct one. How do we do this? We use all our sensors (eyes, ears, nose, hands, etc.) to determine which choice is correct. Let us follow a simple example to find out, by using our eyes, what type of shoe we are wearing.

1. Shoes made of leather 2
1. Shoes made of canvas 5

2. Shoes with laces 3
2. Shoes without laces 4

3. Shoes cut low, below ankles .... Oxfords
3. Shoes cut high, covering ankles .... Boots

4. Leather top of shoe a continuous cover for the foot .... Loafers
4. Leather in strips, leaving open areas for the foot .... Sandals

5. Sole of shoe lightweight, low cut, below ankles .... Running Shoe
5. Sole of shoe heavy, high cut, covering ankles .... Hiking Boot

Assume that you are wearing a pair of canvas running shoes to school. In using the key to identify your type of shoe, the first choice asks if the shoes are made of leather or of canvas.

If they had been made of leather, you would then go to choice #2. Since your shoes are made of canvas, you are directed to go to choice #5. There you are asked if your shoes are lightweight (light weight soles) and low cut or are the heavy weight (soles) and high cut. Yours are lightweight and low cut, thus you have identified them as canvas running shoes.

Note that all dichotomous keys have inherent limitations. In this example, only six types of shoes were included. Even very extensive and technical keys omit some species. This is especially true of exotic species that have been introduced into an area. Many dichotomous keys only include native species. If the plant you are trying to identify isn't a native, or if the keys available to you are not complete for your locale you may need to seek expert help in your quest.

A second limitation of many dichotomous keys is the use of imprecise terminology (low cut, lightweight, etc.). Sometimes it is not clear what the authors of the key meant when presenting their options or choices to you. Frequently, the best keys are those which use objective, measurement-based characteristics, rather than subjective options.

3. Biometry

Tools and Materials

Tubular densiometer (canopy cover measuring tube)
Clinometer
Tape measure
Garden clippers
Brown paper bags
Drying oven
Field form for recording data

Your students will make a series of standard measurements, termed biometry, in naturally vegetated study sites. The biometry measurements are canopy cover, ground cover, tree height and circumference, and grass biomass.

When to Make Biometry Measurements

The canopy cover and ground cover portions of the biometry protocol will be accomplished twice a year where applicable, once near the peak of the growing season when maximum green leaves or grass are present, and once during the least active season (e.g. when broad leaf trees have lost their leaves in temperate regions). If there is no temperature or rainfall-dependent seasonality in your region, measurements need be made only once per year.

The tree height and tree circumference, and grass biomass will be measured once a year. If possible, these measurements should be made near the peak of the growing season in your locality.

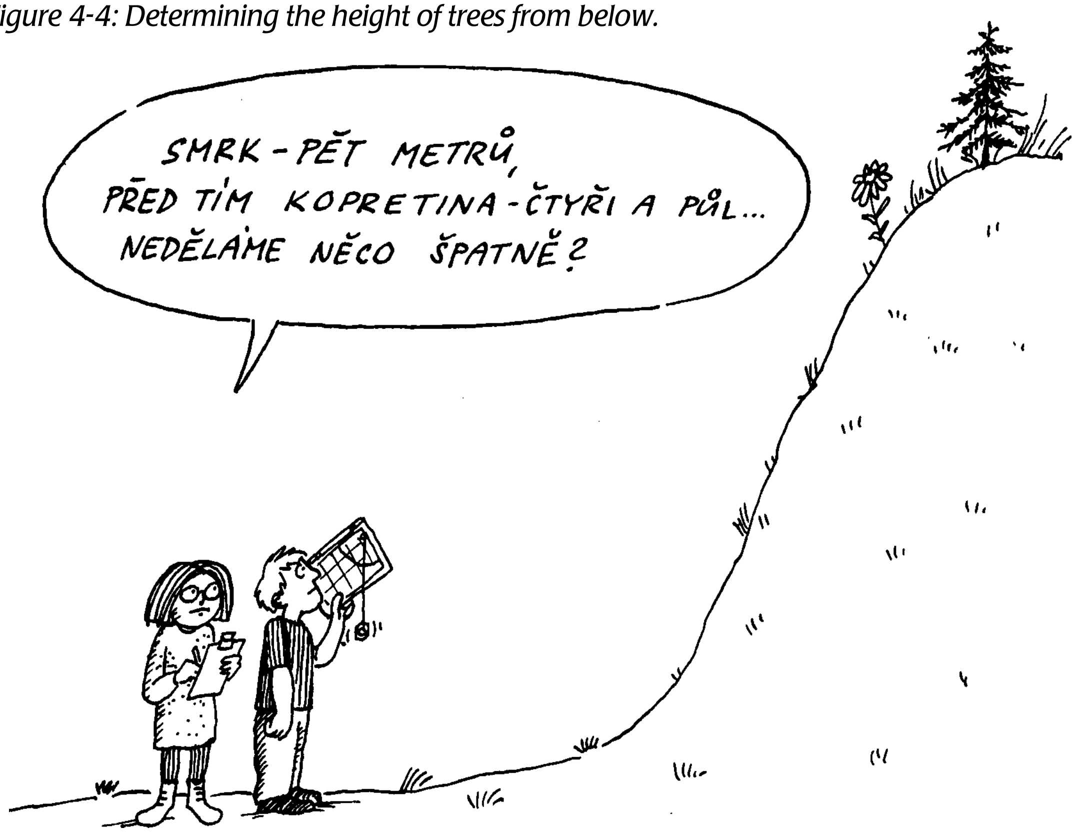
How To Measure Tree Height And Circumference

1. By now, the students have counted the trees reaching the top of the canopy, and have established the dominant species. In some forested sites the co-dominant will also be a tree species.
2. Assuming that there are at least five individual specimens of the dominant species, select for that species the largest tree, the smallest tree (but still reaching the canopy), and three intermediate size trees. These five representative trees should be marked and then measured for height and circumference as described in the following.
3. Repeat the height and circumference measurements for five marked trees of the co-dominant species (if a tree). If fewer than five sub-dominant individuals are found within the site, you may include other species so that the height and circumference of a total of ten trees are measured as a basis for assessing change over time.

Be sure to tag (or mark in some way) the ten trees as you will be measuring them once a year on a continuing basis. The heights (in meters) measured for each of the five trees for the dominant species will now be added together and divided by 5 to obtain an average height. If the co-dominant species is also a tree, the heights of five marked trees should be averaged as above.

Figure 4-3: Determining the height of trees from above.

Figure 4-4: Determining the height of trees from below.

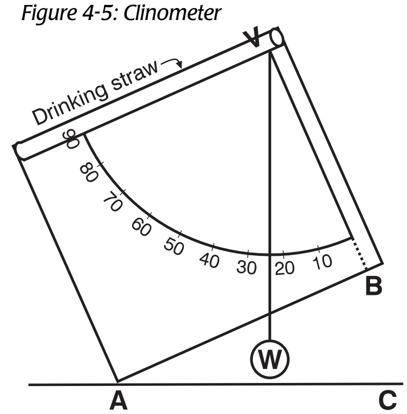


Source: Jan Smolik, 1996, TEREZA, Association for Environmental Education, Czech Republic

How to Measure Tree Height

1. The clinometer is used to measure heights of objects and is an easy device to construct. It is a simplified version of the quadrant, an important instrument in the Middle Ages, and the sextant, an instrument for locating the positions of ships. Each of these devices has arcs which are graduated in degrees for measuring angles of elevation. The arc of the clinometer is marked from 0 to 90 degrees. Refer to Figure 4-5, Clinometer . When an object is sighted through the straw, the number of degrees in BVW can be read from the arc. ∠ BAC is the angle of elevation of the clinometer. What will happen to ∠ BVW as ∠ BAC increases?

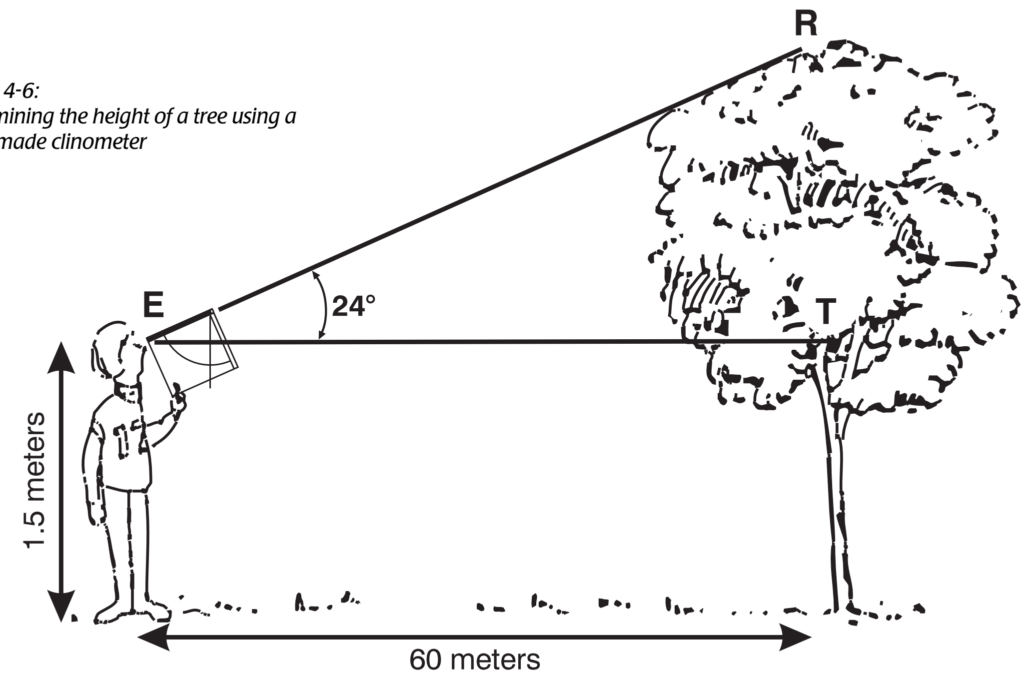
Figure 4-5: Clinometer



Modified from Bennett, A. and Nelson, L. (1961) Mathematics an Activity Approach. Allyn & Bacon: Boston.

∠ BVW on the clinometer is equal to the angle of elevation of the clinometer, ∠ BAC. In the diagram below, the clinometer was used to find the angle of elevation from eye level to the top of the tree. This angle is 24°. The distance from the person to the base of the tree, ET, is 60 meters. The observer's eye is 150 cm. (1.5 meters) above the ground. In this diagram, the person and the tree are not drawn to the same scale.

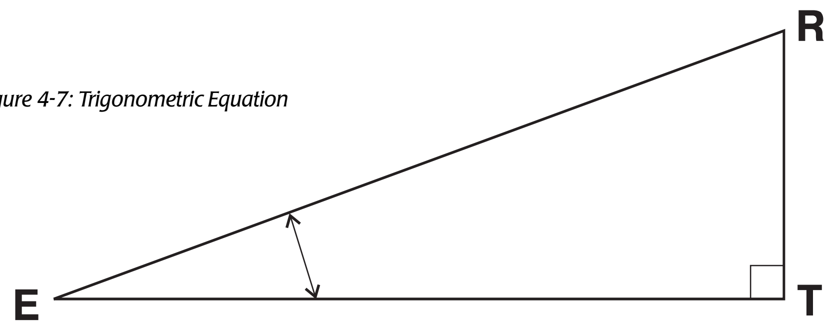
Figure 4-6: Determining the height of a tree using a homemade clinometer



2. Label the triangle below with the given information. Set up a trigonometric ratio to determine the length RT.

   RT=27.0 meters.
   Therefore,
   the height of the tree is 27+1.5=28.5 meters

Figure 4-7: Trigonometric Equation



$$\text{TAN} \angle E = \frac{RT}{ET} \qquad \text{TAN } 24° = \frac{RT}{60} \qquad RT = 60 \text{ TAN } 24°$$

3. Choose a tall object outdoors. Flagpoles or trees are fine, however, it may be better to begin with a feature which can actually be measured with a tape measure, such as a second-story window, a balcony, or a pole which can be placed on the ground and measured before it is erected. With your partner, use the method above to determine the height of the object. Be sure to carefully describe the object you are measuring and its location on this lab sheet. Carefully draw and label diagrams below. Write your trigonometric equation and show all steps in your solution.

4. Now you are prepared to measure the 10 trees, at your Biology Study Site that you have identified and marked, Following the above methodology, and record the height for each of your 10 trees.

Teacher's Note:

1. Circumference: Students will need to bring a flexible metric system tape. The tape must be of sufficient length for students to successfully wrap around the tree trunk at a height of 1.35 meters from the ground.

2. Tree height: When learning to estimate heights, it is helpful to allow students to use informal measurement, i.e., steps, to make estimates. Using the clinometer or hypsometer (at the 45 degree mark), have the students pace off their steps from that spot to the tree. This the height of the tree. Can they convert their pace back into meters?

3. Living Graph of Their Tree Height Results: Using any natural area that has a straight line or you can draw a line, have the students pace off the height that each of them got for the tree. Since their determinations of tree height will probably vary they will be different distances away from the original line. How well did the class do? Possible Accuracy Assessment Here Ask questions like; where are most of the children located? Is there anyone that is far away from most of the children? This living graph can be used to help students develop the concept of data accuracy as well as practicing their pacing.

Figure 4-8: Clinometer Sheet

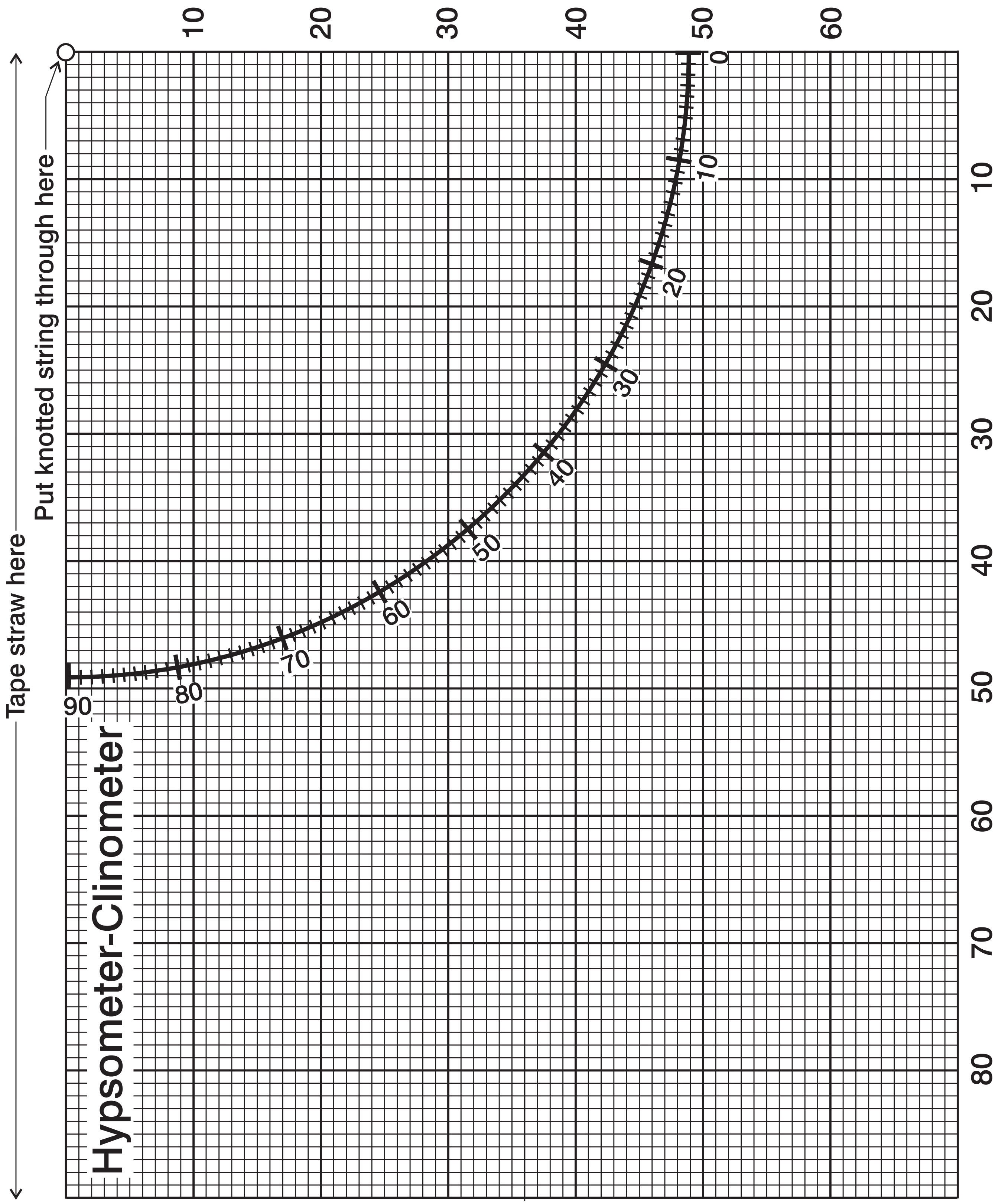


Table 4-3: Table of Tangents

Angle	Tan.	Angle	Tan.	Angle	Tan.	Angle	Tan.	Angle	Tan.
1°	.02	17	.31	33	.65	49	1.15	65	2.14
2	.03	18	.32	34	.67	50	1.19	66	2.25
3	.05	19	.34	35	.70	51	1.23	67	2.36
4	.07	20	.36	36	.73	52	1.28	68	2.48
5	.09	21	.38	37	.75	53	1.33	69	2.61
6	.11	22	.40	38	.78	54	1.38	70	2.75
7	.12	23	.42	39	.81	55	1.43	71	2.90
8	.14	24	.45	40	.84	56	1.48	72	3.08
9	.16	25	.47	41	.87	57	1.54	73	3.27
10	.18	26	.49	42	.90	58	1.60	74	3.49
11	.19	27	.51	43	.93	59	1.66	75	3.73
12	.21	28	.53	44	.97	60	1.73	76	4.01
13	.23	29	.55	45	1.00	61	1.80	77	4.33
14	.25	30	.58	46	1.04	62	1.88	78	4.70
15	.27	31	.60	47	1.07	63	1.96	79	5.14
16	.29	32	.62	48	1.11	64	2.05	80	5.67

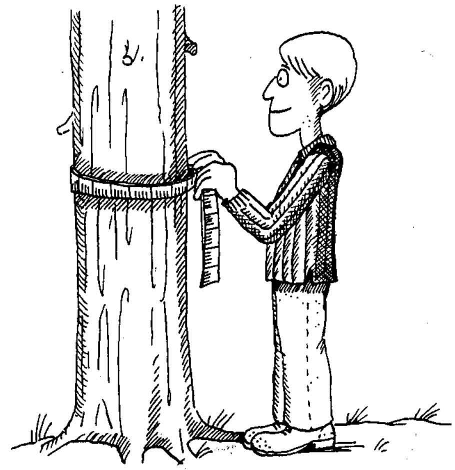
Example: Assume you have established a baseline distance of 60 meters. Assume that you have measured the tree top to an angle of 24°. From the Table, you will see that the tangent of 24° is 0.45. Therefore, the tree height is 60m x 0.45 = 27 meters. By adding the height of the eyes of the observer (1.5m), the total tree height is 28.5 meters.

How To Measure Tree Circumference

The tree circumference for each of the five (or ten) trees for which you previously measured height will now be acquired. The circumference of these trees will be measured 1.35 m (approximately 4.5 feet) above ground level. This height (1.35 m) is termed breast height. The science community refers to this term as "**Circumference at Breast Height" (CBH).** <u>Note change– circumference at breast height is now reported to GLOBE rather than diameter.</u>

Using a standard meter tape, your students will measure the circumference of each tree at a height of 1.35 m above the ground. The circumference will be reported in cm.

Note: For example, if your tree has a circumference of 150 centimeters, be sure to report it in centimeters, and not meters and centimeters.



Source: Jan Smolík, 1996, TEREZA, Association for Environmental Education, Czech Republic

How To Measure Grass Biomass

If your site has as its dominant or co-dominant species a grass, you will measure the total mass per unit area of live (green) and senescent (brown) vegetation; this is referred to as biomass. This is an important biometric characterization of grasslands, providing information comparable to the height and circumference measurements of forest canopies. Biomass data are important for documenting land cover, and for use in assessments and models of water and nutrient cycling in the biosphere. Do not perform the biomass protocol in vegetation types other than grasses, even if they form a dominant or co-dominant species in the site.

Procedure

This procedure is performed in any ground study site having grass as the dominant or co-dominant species (i.e. MUC classes 41, 42 or 43). The study site could be either the Biology Study Site close to your school, and/or in one or more Land Cover Study Sites. You will work in the Biology Study Site or in the center 30 x 30 meter part of the Land Cover Study Site. Within the plot, proceed as follows:

1. Choose a minimum of three random sampling locations. You may use more if you want to involve more students, but try not to defoliate a large percentage of the plot as it may not regrow naturally in future growing seasons. Random locations can be identified by having a blindfolded student spin in the center of the pixel and toss an object away from his/her position; the landing point of the object is the random location. You can also use tables of random numbers to generate coordinate of sampling locations by selecting a pair of random numbers and using each value in the pair to specify a coordinate on two adjacent sides of the pixel. (e.g. If the pair were 09/24, then starting at a corner, measure 9 meters along one side and 24 meters along the adjacent side, and sample where lines laid from these coordinates perpendicular to the sides intersect within the plot.)
2. At each sampling location, mark out a square, one meter on a side, either using a tape measure and marking the corners, or by means of a simple, portable frame constructed with sides that are one meter inside length, which you can use repeatedly without having to measure each plot.
3. Clip out all vegetation within one meter square as close to the soil surface as possible, using garden clippers or strong scissors. The square should be devoid of vegetation, except for short stubs, when you finish.

Note: As with the ground cover measurement, "vegetation" means material, live or dead, which is still rooted in the ground. Do not collect unattached leaves or litter.

4. Sort the clipped material into living and senescent portions. A rule of thumb is that a stem or leaf which has any green color in it is considered living, and only material that is entirely non-green is considered senescent. Sometimes this sorting is easily accomplished in the field as the material is being clipped, or you may return the unsorted samples to school and sort them there, as long as the sorting is done within approximately 24 hours of clipping.
5. Place the living and senescent portions in separate brown paper (not plastic) bags, and label the bags so you can identify the sample locations and portion in each bag. If your plot has very extensive growth, it may take several bags to contain all the material. Using several small bags rather than one large one in this instance will simplify drying and weighing.
6. Dry the bagged samples in an oven at a temperature no higher than 50 to 70 C. The time needed to completely dry the samples will vary according to their size and other factors. For the first few samples, remove the bags and weigh them once a day, and return them to the oven until two consecutive measurements give the same weight. They are then dry enough for final weighing. After a while, you will develop a sense for how long complete drying takes – usually two to three days – and need not repeatedly weigh the samples.

   Note: <u>You should use an oven designed for drying chemicals or biological samples at low temperatures. Do not use a conventional cooking oven; they are not designed to operate safely at the relatively low temperatures needed for sample drying.</u>

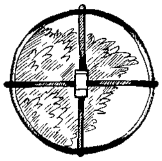
   If you live in a dry, sunny climate, drying may also be accomplished by spreading the bags out in a sunny location, and turning them over once or twice a day. Use the same periodic weighing described above to determine when they are completely dry.
7. When the samples are completely dry, remove them one at a time from the oven and weigh them, then shake out the contents, weigh the empty bag, and subtract the empty bag weight from the total weight to get the weight of the vegetative material alone. If your bags are all the same size and construction, you will find that they are virtually identical in dry weight and you can use the average of the first few empty bag weights to subtract from subsequent total sample weights. All weighing should be done with an analytical balance or other laboratory instrument, capable of accurately measuring weights to +/- one gram. Most simple "triple beam" balances are capable of this level of accuracy. Enter the weight in grams of living and senescent material from each of the three samples on the field form. Calculate the average weights of the three samples at each plot, enter it in the summary section of the field form, and report it to the GLOBE Student Data Server along with the other biometry data.

Making The Canopy Cover And Ground Cover Measurements

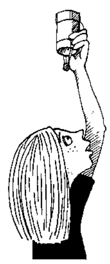
The amount of vegetation present on the ground has a direct influence on how a satellite "sees" the surface within the site. Your mission is to find out how much of the study site is covered by vegetation- as a forest canopy and/or as ground cover.

At least one student will cross the site diagonally from the southeast corner to the north-west corner and a second student will cross diagonally from the northeast corner to the southwest corner (see below). After each pace, the canopy and/or ground cover will be recorded on the field form.

1. Take a tube that is approximately 4 cm in diameter and 7.5 cm long and attach two pieces of string across the opening at one end to form a crosshair.



2. Attach another 18 cm piece of string with a metal nut or washer hanging loosely at the opposite end of the tube. See Figure 4-9.



Procedure
For Canopy

1. After each pace the student will look up at the canopy through the tube, making certain that the metal nut/washer is directly below the intersection of the crosshair at the top end of the tube.

2. If the student sees vegetation touching the crosshair, another student will record that as a (+) on the field form. If there is no vegetation touching the crosshair, this will be recorded as a (-).

For Groundcover

While standing in the same place, the student will look down and if there is **vegetation** touching his/her foot or leg *below the knee*, the other student will record a (g) on the field form if the vegetation is green, or a (b) on the field form if it is brown vegetation touching the foot or leg. Do not consider unattached leaves and twigs as vegetation; to be considered vegetation, the plant material, green or brown, must be attached to a recognizable stem or branch which is rooted in the ground. Vegetation *under*

Source: Jan Smolik, 1996, TEREZA, Association for Environmental Education, Czech Republic

the foot counts as "touching" and should be recorded as a (g) or (b). If there is *no* vegetation touching the foot or leg, a (-) will be recorded.

These actions will be repeated after each pace until the opposite corner of the site is reached. Use the field form

Figure 4-9: Diagram of homemade densiometer

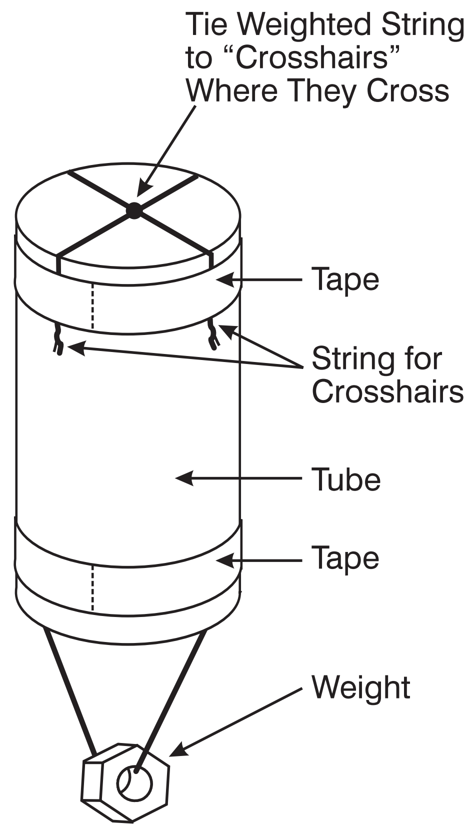
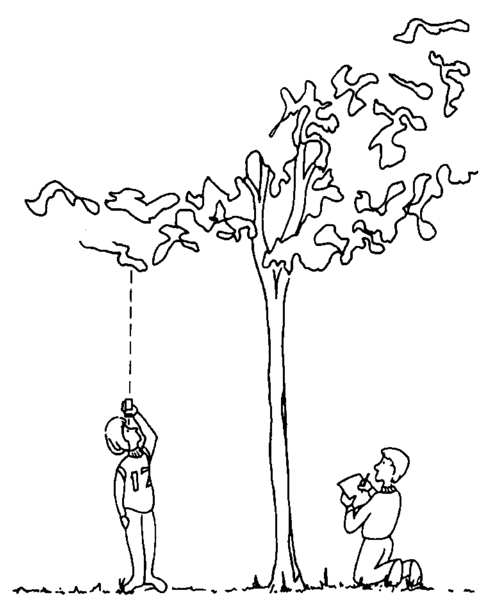


Figure 4-10: Example using a homemade densiometer



provided to record the +'s, g's, b's, and -'s. Numerous pairs of students should perform this measurement protocol and average the data.

Note: If an obstacle is directly in your line of travel, pass to the side of the obstacle that causes the least deviation from the intended track.

Result/Conclusion: After the conclusion of the measurements, the students will then total the number of +'s (for the canopy), and the total number of g's and b's (for ground cover). Divide each total by the total number of observations and multiply by 100 to determine the percentage canopy and percentage ground cover in the site, as follows:

For Canopy

1. Add up plusses (+'s) for canopy and divide by total canopy observations, plusses plus minuses (+'s + –'s).
2. Multiply answer by 100 to get % (percentage) of canopy cover.

For Groundcover

1. Add up g's for groundcover and divide by total (g's +b's + –'s) groundcover observations.
2. Add up b's for ground cover and divide by total (g's +b's + –'s)ground cover observations.
3. Multiply answers by 100 to get % (percentage) of green and brown ground cover, respectively.
4. Add green and brown ground cover together to obtain total ground cover.

Entering Study Site Observations on the Data Work Sheet

A form has been provided for your use in recording the observations and measurements made in your Land Cover and Biology Study Sites. Refer to the Land Cover/Biology Investigation Data Work Sheet in the Appendix to this investigation. A separate form should be used for each site and measurement episode. The form contains spaces for every possible ground observation and measurement, so in any particular instance you may leave portions blank. For example, there will be no tree height and circumference data if the site is non-forested, or if you are doing "qualitative" observations in a Land Cover Study Site.

Here is a brief summary of the data fields on the form:

1. **Site Identification:** Identify whether you are working in a Biology or Land Cover Study Site. If Land Cover, then designate as "training" or "validation," and "qualitative" or "quantitative."
2. **Site Name:** The identifying name you and your students give to a particular study site.
3. **Country/State/City:** Standard identifiers of the locality.
4. **GPS Location:** The latitude and longitude of the site's center point determined using the GPS.
5. **Date and Time:** The date and time of the field observations.
6. **Recorded by:** The name of the student or other person entering data on the form.
7. **MUC Land Cover Class Level 3 and 4:** Record the name and the numerical code of the best match to the site cover type from the Modified UNESCO Land Cover Classification System (MUC). If the cover is identified as urban or agricultural you may stop, since the other observations/ measurements are for natural vegetation.

8. **Dominant and Co-Dominant Species:** Enter the first 4 letters of the genus and of the species name of the dominant and co-dominant species identified. These are the names that will be entered in the GLOBE database. This is a change from earlier GLOBE instructions - no longer are students to use a letter or number identifier for their species.

9. **Canopy Cover:** Space is provided for students to record the (+) and (-) observations for canopy cover using the tube or densiometer method.

10. **Ground Cover:** Space is provided for students to record the (g), (b), and (-) observations for ground cover.

11. **Number, Height, and Circumference of trees:** Space is provided for students to record the number of trees, and the height and circumference measurements on five representative specimens. Use the appropriate column for dominant or co-dominant species. If grasses are the dominant and/or the co-dominant, leave the tree data blank.

12. **Green/Brown Biomass:** Record the dry weight green and brown biomass for each of the three grass plots. This will be done at school, after drying the samples. If grass is not the dominant or co-dominant species, leave these fields blank.

13. **Biometry Summary:** Space is provided for the calculated canopy cover, green and brown ground cover, and the average tree height, circumference, and biomass obtained from the combining of the multiple samples. All the items marked by a star on the data form will be reported on the GLOBE Student Data Server.

14. **Photographs, Notes:** Record relevant field observations such as weather conditions, the number and orientation of photographs taken, etc.

Refer to Seasonal Changes in your biometry post-protocol section in the learning activities

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